

LAYER BY LAYER

BUILDING A 3D PRINTING SERVICE
FROM THE GROUND UP

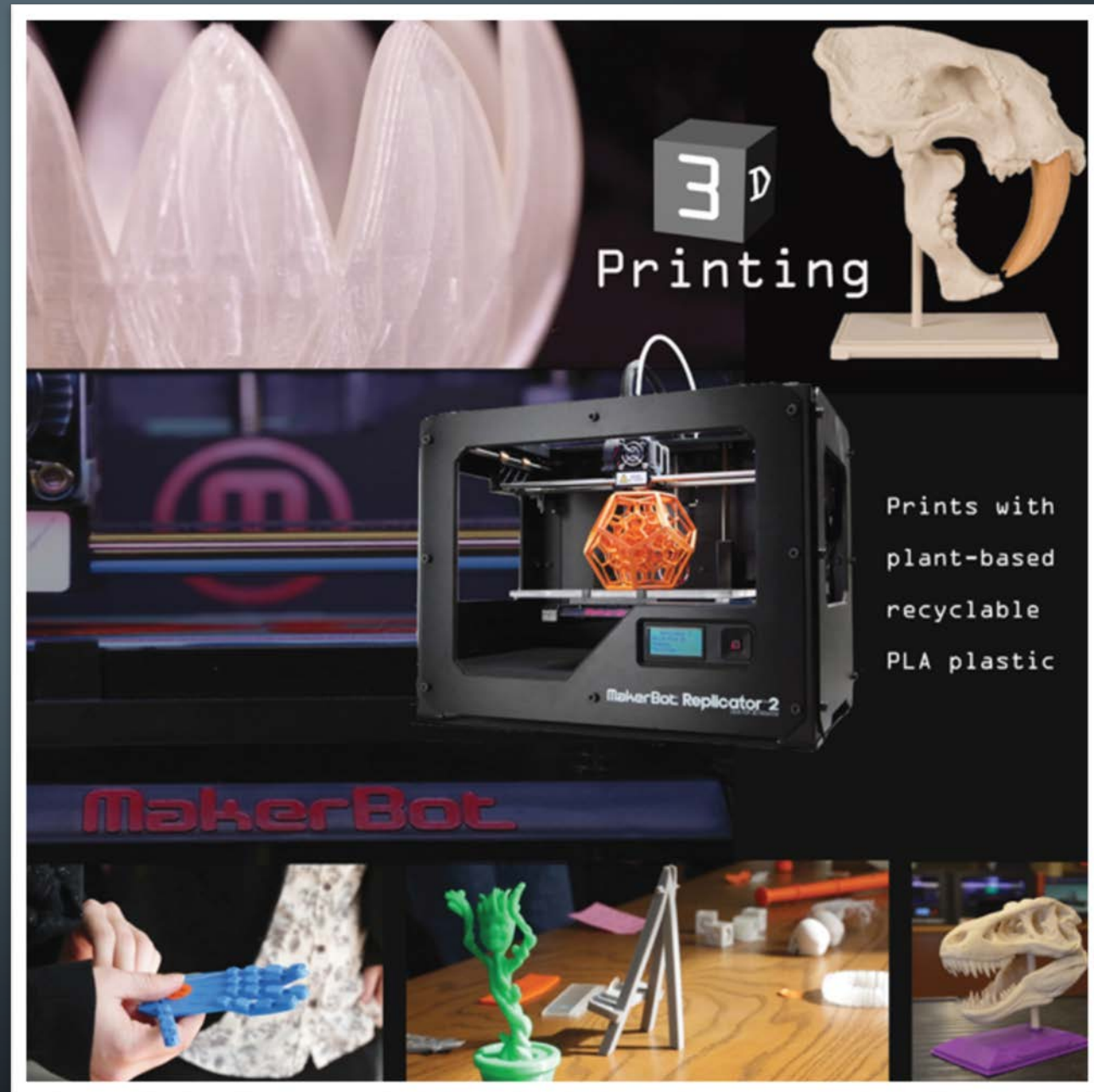
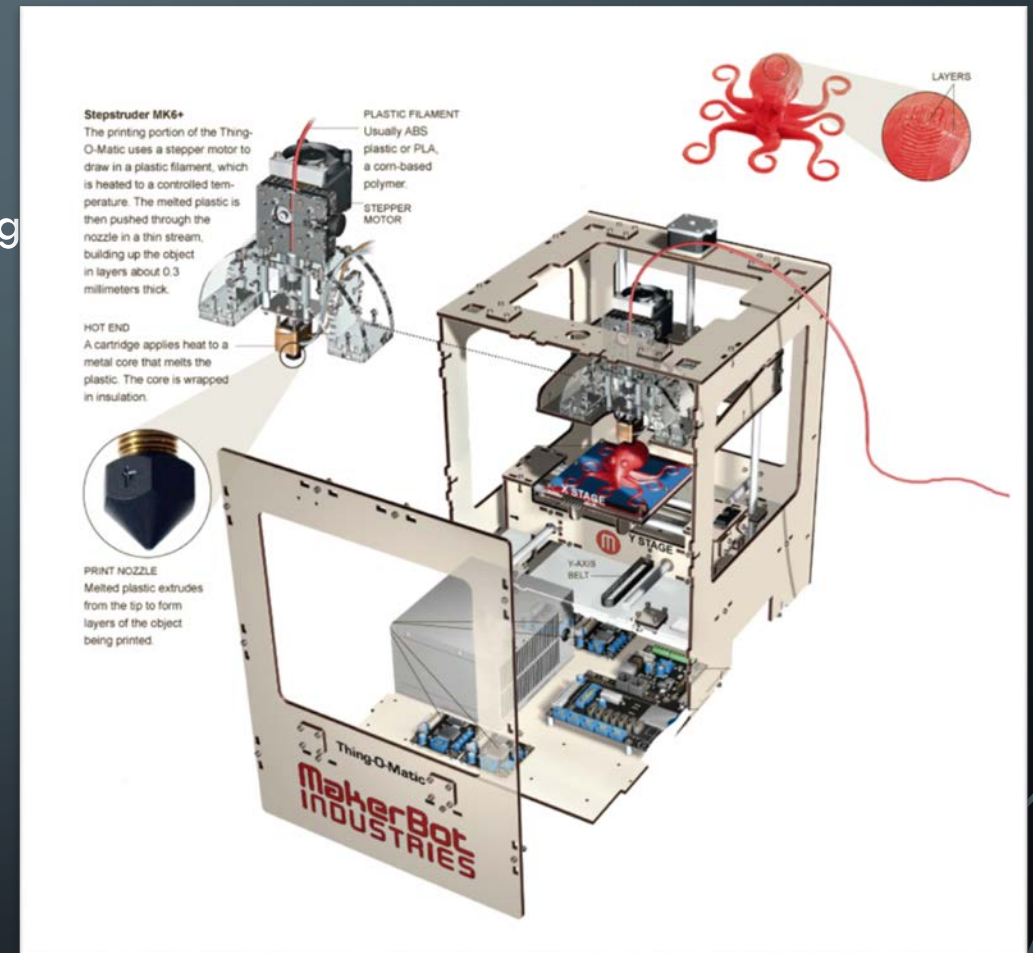


Image: Nattawan Wood

WHAT IS 3D PRINTING?

- General overview of technology
- Terminology
 - Fused Deposition Modeling (FDM) – process of melting layers together
 - Slicing – turns digital 3D models (STL) into thin layers
 - Filament – material used to print (PLA and ABS)
 - Extruder – draws layers at different “resolutions”
0.1 mm – 0.3 mm; like a hot glue gun
 - Build Plate – printing surface (tip: use painter’s tape)

PS - If you like any of our wording, approaches, etc..., please feel free to borrow/copy anything you see.



WHAT IS 3D PRINTING?



INITIAL INVESTIGATIONS: ENVIRONMENTAL SCAN

- **Questions we asked:**

- What's available on campus already?
- What does the community have to offer?
- What are other institutions doing?



INITIAL INVESTIGATIONS: USER BASE

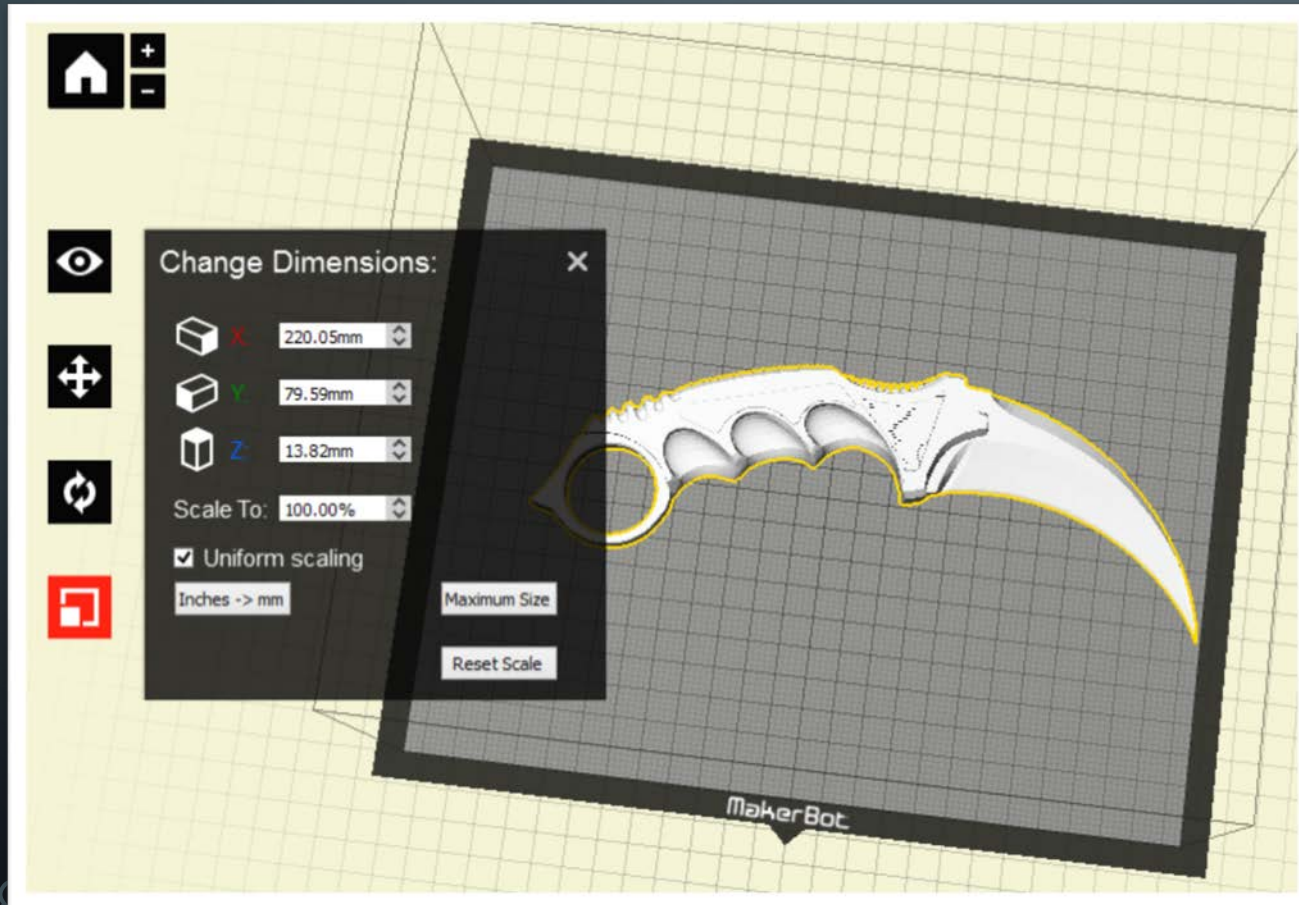
- Questions:
 - Who will have access? When?
 - What does your user base need?
- Use these answers to determine the best **Service Model**
 - Open
 - Mediated



INITIAL INVESTIGATIONS: POLICIES

- Policies

- Right to refuse service – dangerous, harmful material, poorly designed items
- To clean or not to clean; quality guarantee
- Level of access to printers and referrals
- Prioritizing requests – academic versus personal
- Modeling Resources – <http://www.library.arizona.edu/services/print/3D/about>



INITIAL INVESTIGATIONS: POLICIES - COPYRIGHT

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- I grant permission to the University of Arizona and its agents to reproduce the photocopy or other reproduction and return them to me, and I have the legal right and authority to grant this permission.
- I will use the photocopy or other reproduction only for private study, scholarship, or research.
- I will not use them for any commercial purpose or allow any third party to do so.

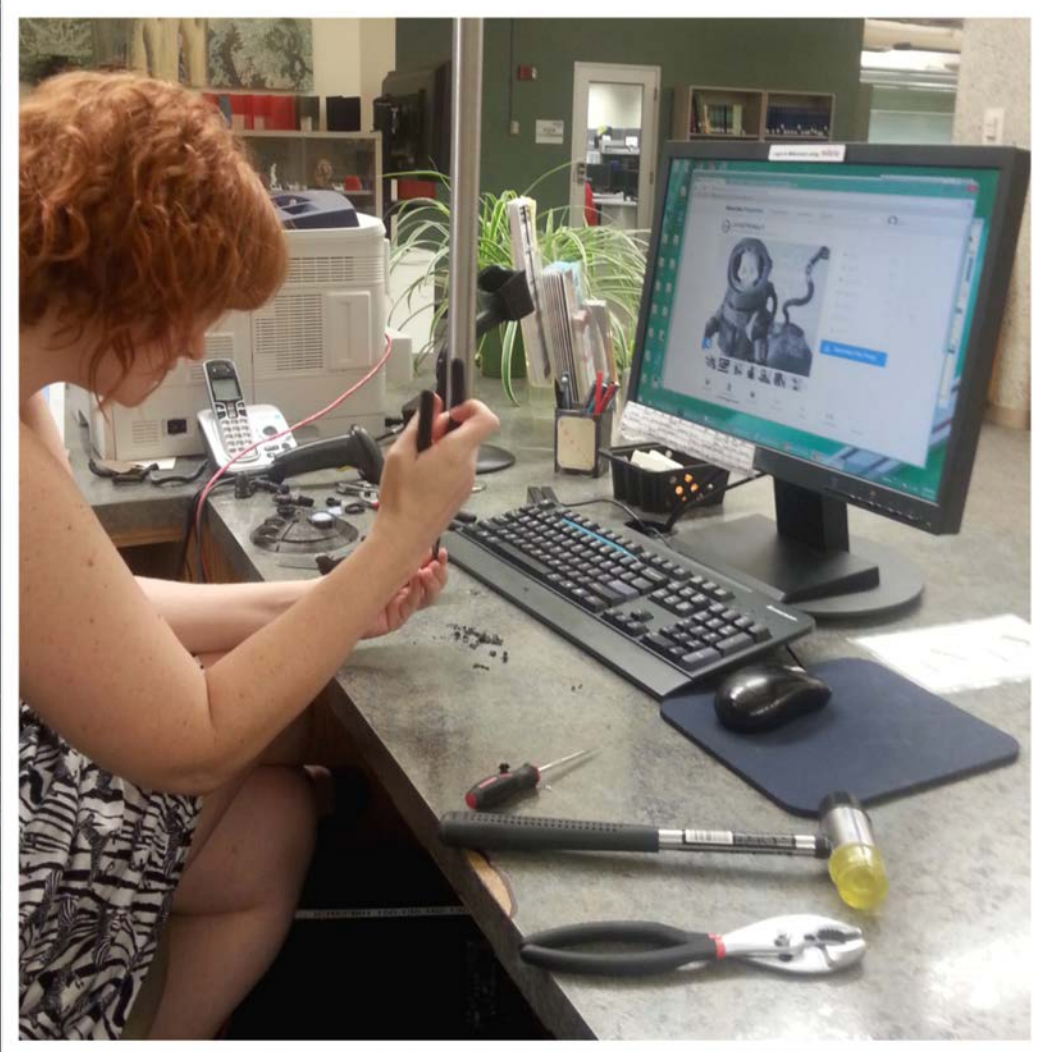
IMPLEMENTATION: EQUIPMENT COSTS

- MakerBot Replicator 2: \$2,200
 - Glass Build Plate: \$275
 - Painters Tape: \$50
 - Filament: \$500
 - MakerCare Service Plan: \$350

Total initial cost: \$3,375

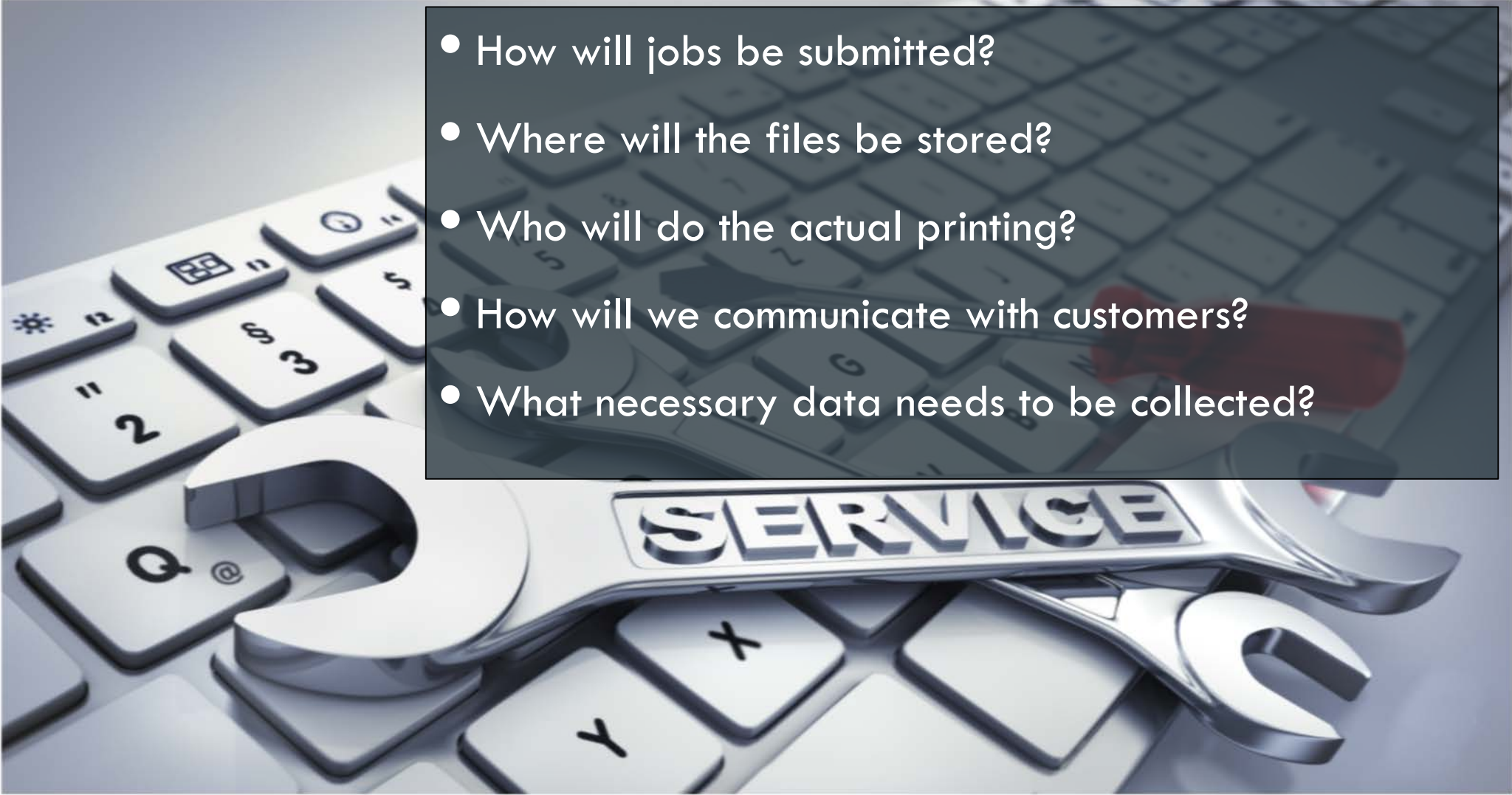


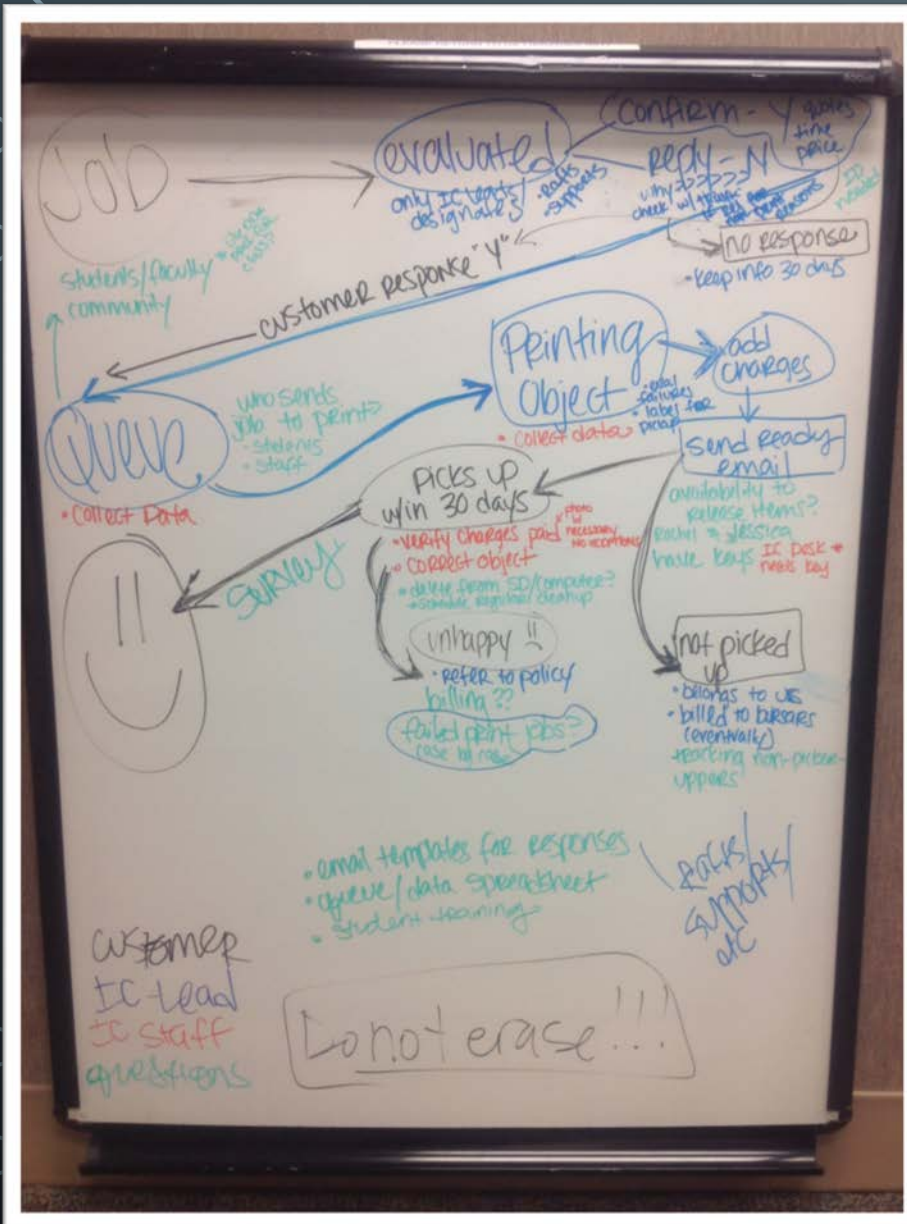
IMPLEMENTATION: STAFFING



- Staff Support ~0.5 FTE - Job Descriptions :
 - ~0.25 FTE - 3D Printing training and coordination of issues. Assessment and benchmarking to make recommendations for supply, refresh, changes in technology or policy and procedures; provide software and technology support and training for library staff, part-time student employees and library customers
 - ~0.1 FTE - 3D printing support. Assists with training of staff, part-time student employees, and customers. Assists with managing procedures.
 - ~0.1 FTE – 3D printing queue processing
- Student Support – added to existing duties

PROCESS WORKFLOWS

- 
- How will jobs be submitted?
 - Where will the files be stored?
 - Who will do the actual printing?
 - How will we communicate with customers?
 - What necessary data needs to be collected?



IMPLEMENTATION: SUBMISSION FORM

UA's Form:

<http://new.library.arizona.edu/visit/print/3D/request>

Key Elements:

- Contact Info
- Delivery Info – date needed, who will pick up
- Print Specifications – dimensions, color, infill, resolution
- Pre-authorization and agreement
- Metrics – what data do you need them to supply?

The screenshot shows a web form titled "Tell us your story" with a sub-header "Let us know more about your project and you may be eligible for discounted printing rates." The form contains several sections: "Is this an original design? *" with radio buttons for "Yes" and "No"; "Is this for a class?" with radio buttons for "Yes" and "No"; "Course number & title" with a text input field; "Instructor" with a text input field; "The fine print" section containing "Payment & turnaround options *" with three radio button options, and "Agree to policies *" with a checkbox and a line of text linking to "3D printing policies" and "intellectual property rights".

Tell us your story

Let us know more about your project and you may be eligible for discounted printing rates.

Is this an original design? *

☐ Yes

☐ No

Is this for a class?

☐ Yes

☐ No

Course number & title

Instructor

The fine print

Payment & turnaround options *

☐ I authorize printing if my job will cost less than \$10 and take less than 2 weeks

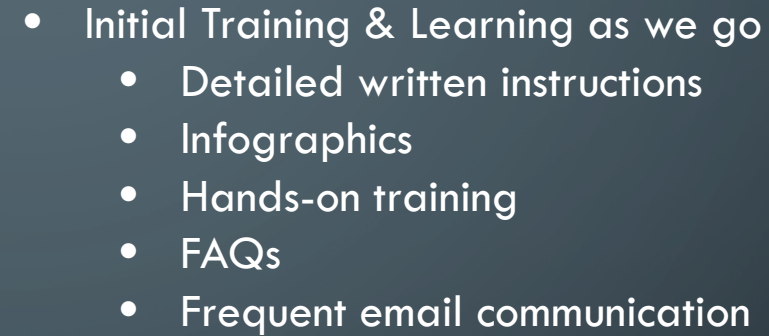
☐ I authorize printing regardless of cost and expected completion time

☐ Contact me with an approximate cost and expected completion time

Agree to policies *

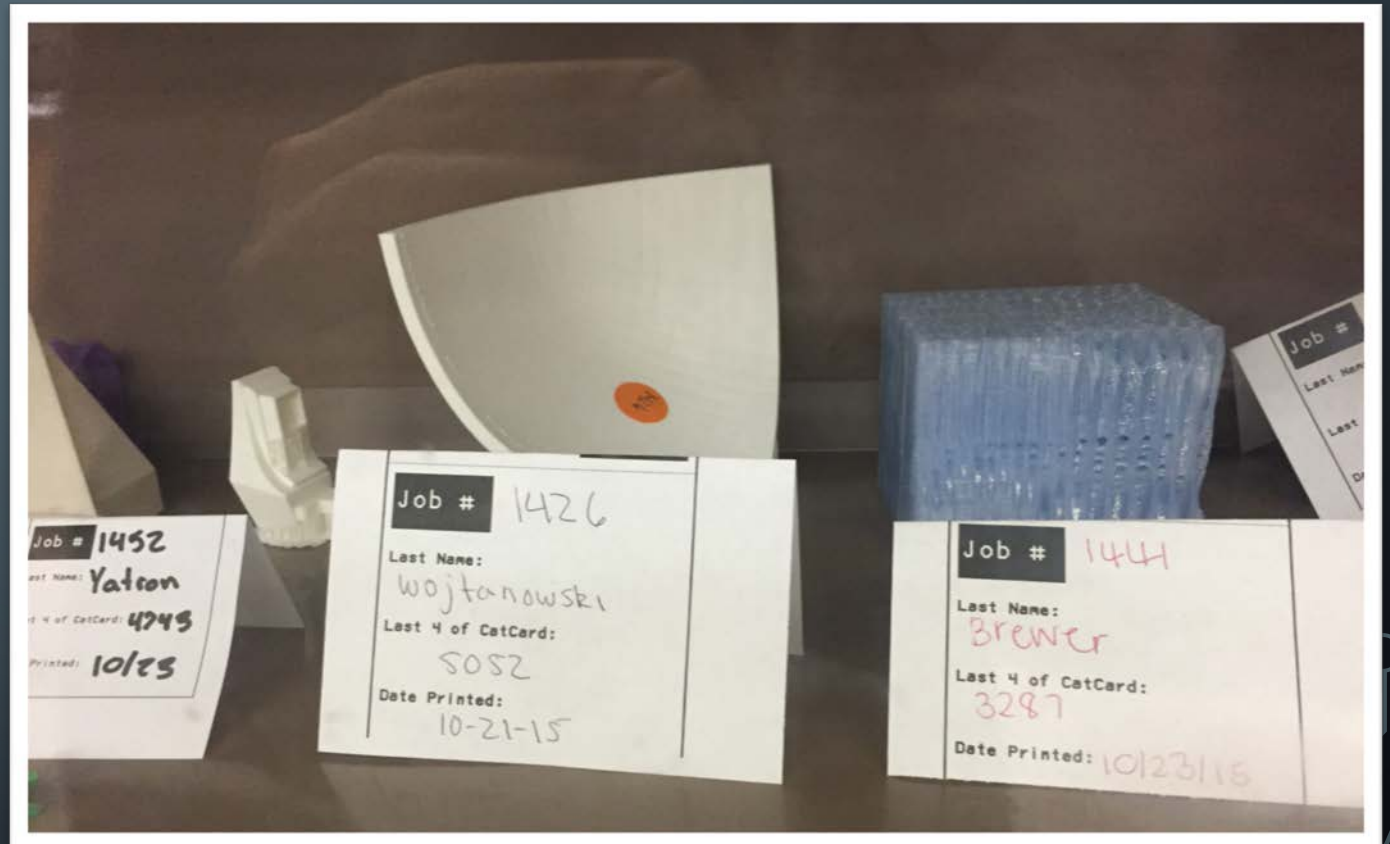
☐ I have read and agree to the library's [3D printing policies](#) and certify that I have [intellectual property rights](#) to authorize reproduction.

➡ Goal: Educate students & staff to make informed decisions



REVIEW: METRICS

- Demographics
 - Affiliation (Undergraduate, Graduate, Faculty, Staff, Community, etc)
 - College & Department
 - Discrete users
- Amount saved
- Demonstrating value



→ What does this look like?

ID #	Date Rec'd	Cost ID	EMAIL	CATCARD	File Name	Color	Refu / Support	Est Weight	Est Time (min)	Est Charge	Date Needed	Est Htg ft	Est Wdth in	Est Lengh in	For a Class	Affiliation	College
1455	10/22/15 12:53	272	Matthew Gabriel	mgabriel@email.arizona.edu	60170902022786546	1455_11thDoctorSonicScrewdriver_White	White	N/N	86.25	412	\$8.63					Graduate	Honors
1456	10/22/15 18:54	273	Kyle R. Vazquez	kvazquez@email.arizona.edu	6017090202183693	1456_casajun_greedy_bell_repair_Cool gray	Cool gray	N/N	31.81	351	\$3.16					Graduate	Honors
1457	10/23/15 9:32	274	Brian Herrera	bhererra@email.arizona.edu	60170902023257141	1457_defiant.stl	Black	N/N	64.73	477	\$6.47					Graduate	Honors
1458	10/23/15 10:00	50	Michael Spoult	mspoult@email.arizona.edu	6017090202324079	1458_heart_inks_small.stl	Red	N/Y		\$0.00						Undergraduate Honors	College of Agriculture and Life Sciences
1459	10/23/15 10:09	50	Michael Spoult	mspoult@email.arizona.edu	6017090202324079	1459_heart_inks_small.stl	Red	Y/N	2.77	11	\$0.28					Undergraduate Honors	College of Agriculture and Life Sciences
1460	10/23/15 12:25	179	Bill Sandel	sandel@arizona.edu	6017090202041801	1460_Othello_Lun_Minifigure-Orn	Black	N/N	25.13	110	\$2.51					Other Affiliate/Community	College of Agriculture and Life Sciences
1461	10/24/15 12:22	255	Theresa Jones	tsjones@arizona.edu	6017090202041801	1461_Othello_Lun_Minifigure-Orn	White	Y/Y	3.71	43	\$0.37					Other Affiliate/Community	College of Agriculture and Life Sciences
1462	10/24/15 17:34	275	Alex Urua	aurua@email.arizona.edu	6017090202323532	1462_PDB-1IGT-ribbon-thick.stl	Photochrom	Y/Y	83.34	600	\$8.33					Graduate	College of Agriculture and Life Sciences
1463	10/25/15 8:42	194	Shawn Protz	sprotz@email.arizona.edu	6017090202012405	1463_151027_DigitalCave_fixed.stl	Photochrom	Y/Y	151.4	827	\$15.14					Faculty	College of Agriculture and Life Sciences
1464	10/25/15 9:36	263	RENE GARCIA	renege@gmail.com	N/A	too large for BP	Translucent purple			\$0.00						Other Affiliate/Community	College of Agriculture and Life Sciences
1465	10/25/15 10:32	263	RENE GARCIA	renege@gmail.com	N/A	possibly will need to be resized to	Clear			\$0.00						Other Affiliate/Community	College of Agriculture and Life Sciences
1466	10/25/15 18:27	35	Steven Rack	srack@email.arizona.edu	6017090202063078	1466_phonocaster1.stl	Black	N/N	22.57	100	\$2.26					Undergraduate	College of Agriculture and Life Sciences
1467	10/26/15 7:31	243	Silvana Ayala	sayala@email.arizona.edu	6017090202055453	object too small	Army green			\$0							
1468	10/26/15 12:41	35	Steven Rack	srack@email.arizona.edu	6017090202063078	1468_phonocaster1.stl	Red	N/N	4.9	21	\$0						
1469	10/26/15 12:48	35	Steven Rack	srack@email.arizona.edu	6017090202063078	1469_phonocaster2.stl	Black	N/N	22.11	99	\$2						
1470	10/26/15 19:36	251	Andrew Wojtanowski	awojtanowski@email.arizona.edu	601709020203185052	1470_cave_open_v2.stl	Red	N/N	13.47	97	\$1						
1471	10/26/15 19:36	251	Andrew Wojtanowski	awojtanowski@email.arizona.edu	601709020203185052	1470_cave_open_v2.stl	Army green	Y/N	3.33	55	\$0						
1471	10/27/15 10:24	276	Patrick Kelley	pkelley@email.arizona.edu	60170902020815253	http://new.library.arizona.edu/hlter Worm gray	Worm gray			\$0							
1472	10/27/15 11:09	277	Connor Holden	connorholden@email.arizona.edu	60170902020320400	1472_Number 1_fixed_resized.stl	Clear	Y/Y	163.1	907	\$16						
1473	10/27/15 11:34	278	gwennel misslifer	gwennelmisslifer@gmail.com	60170902023263433	1473_test tube.stl	Clear	N/N	5.72	31	\$0						
1474	10/27/15 11:58	279	Beno Vargas	benovargas@email.arizona.edu	601709020203089759	http://new.library.arizona.edu/hlter Photochromatic magenta	Photochromatic magenta			\$0							
1475	10/27/15 17:46	344	Baoum C. Sorete	bsorete@email.arizona.edu	6017090202063078	1475_Wheel_CD_Rene_Garcia.stl	Translucent	N/N	56.52	405	\$5						
1475	10/27/15 17:46	344	Baoum C. Sorete	bsorete@email.arizona.edu	6017090202063078	1475_Wheel_CD_Rene_Garcia.stl	Translucent	N/N	56.52	405	\$5						
1476	10/27/15 19:10	263	RENE GARCIA	renege@gmail.com	N/A	1476_Wheel_CD_Rene_Garcia.stl	Translucent	N/N	56.52	405	\$5						
1477	10/27/15 19:15	263	RENE GARCIA	renege@gmail.com	N/A	1477_Box_81_Rene_Garcia.stl	Photochrom	N/N	19.24	134	\$1						
1478	10/27/15 20:09	280	Nicholas Zolkowski	nickszolkowski@email.arizona.edu	6017090202063078	1478_Box_81_Rene_Garcia.stl	Photochrom	N/N	19.24	134	\$1						
1479	10/27/15 22:03	265	Janet Towle	jtowle@email.arizona.edu	6017090202063078	1479_Box_81_Rene_Garcia.stl	Photochrom	N/N	19.24	134	\$1						
1479	10/27/15 22:03	265	Janet Towle	jtowle@email.arizona.edu	6017090202063078	1479_Box_81_Rene_Garcia.stl	Photochrom	N/N	19.24	134	\$1						
1480	10/27/15 23:24	35	Steven Rack	srack@email.arizona.edu	6017090202063078	1480_jacobbleholder_fixed.stl	Black	N/N	14.80	100	\$1						
1481	10/28/15 12:59	281	Abhishek Rane	arane@email.arizona.edu	6017090202063078	1481_blackbox 3D print.stl	Black	N/N	14.80	100	\$1						
1482	10/28/15 14:43	256	Nathan Lyne	nllyne@email.arizona.edu	6017090202063078	1482_blackbox 3D print.stl	Black	N/N	14.80	100	\$1						
1483	10/28/15 16:07	289	Hofey Quinn	hofeyquinn@email.arizona.edu	6017090202063078	1483_blackbox 3D print.stl	Black	N/N	14.80	100	\$1						
1484	10/28/15 21:09	36	Steven Rack	srack@email.arizona.edu	6017090202063078	1484_blackbox 3D print.stl	Black	N/N	14.80	100	\$1						
1485	10/29/15 10:13	282	Code Shaw	codeshaw@email.arizona.edu	6017090202063078	1485_model_show.stl	Photochrom	Y/Y	221.51	1036	\$22						
1486	10/29/15 10:13	383	Daniela Nunez	dnunez@email.arizona.edu	6017090202063078	1486_model_show.stl	Photochrom	Y/Y	221.51	1036	\$22						
1487	10/29/15 10:14	255	Theresa Jones	tsjones@arizona.edu	6017090202063078	1487_model_show.stl	Photochrom	Y/Y	221.51	1036	\$22						
1488	10/29/15 10:19	255	Theresa Jones	tsjones@arizona.edu	6017090202063078	1488_model_show.stl	Photochrom	Y/Y	221.51	1036	\$22						

Lots of
Spreadsheets!

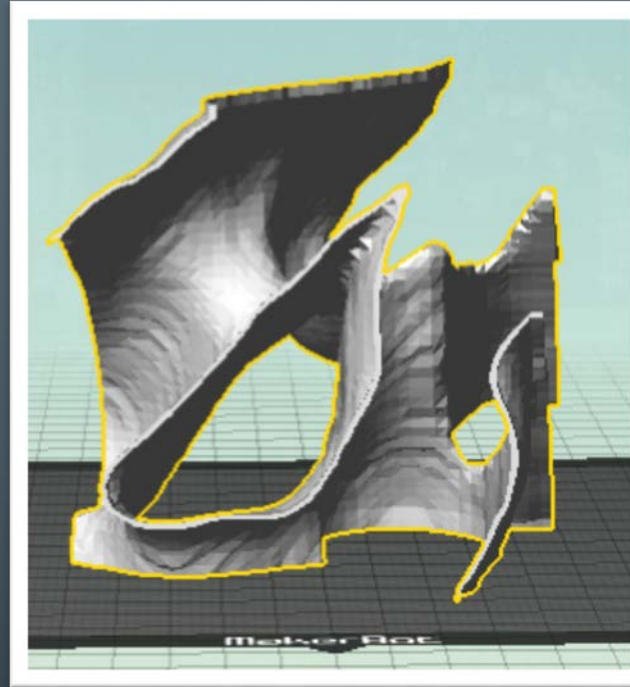
CUSTOMER NAME	EMAIL	CATCARD	AFFILIATION	COLLEGE	DEPARTMENT
1 Ryan Jones	ryanjones@email.arizona.edu	6017090202043997	Staff	n/a	UA Library
2 Deborah Quintana	quintana@email.arizona.edu	6017090202334958	Staff	n/a	UA Library
3 Tim Franco	franco@email.arizona.edu	6017090202036271	Staff	n/a	UA Library
4 Shoshana Mayden	smayden@email.arizona.edu	6017090202517719	Staff	n/a	UA Library
5 John Miller Wells	johnmillerwells@gmail.com	6017090202025191	Staff	n/a	UA Library
6 Andrew See	andrewsee@email.arizona.edu	60170902020303909	Staff	n/a	UA Library
7 Desone Burns II	dburns@email.arizona.edu	6017090202389143	Undergraduate	College of Science	CSC Computer Science
8 Alex Moore	amoores22@gmail.com	6017090202069964	Undergraduate	College of Science	MCB Molecular & Cellular Bio
9 Amber Burt	amburburt@email.arizona.edu	60170902020704065	Undergraduate	College of Agriculture and Life Sciences	Undeclared
10 James Wadsworth	jamesw2@email.arizona.edu	6017090201869439	Undergraduate	College of Social and Behavioral Studies	ANTH Anthropology
11 Beau Smith	bsmith@email.arizona.edu	6017090202292943	Graduate	College of Agriculture and Life Sciences	GEOS Geosciences
12 June Maszke	jmaszke@email.arizona.edu	6017090202023493	Undergraduate	College of Social and Behavioral Studies	US History
13 Megan Supa	msupa@email.arizona.edu	6017090202072033	Undergraduate	College of Science	Undeclared
14 Tyler Gostelum	tylertgostelum@email.arizona.edu	6017090202739263	Undergraduate Honors	College of Medicine - Tucson	SOC Sociology
15 William Simpson	wsimpson@email.arizona.edu	6017090202288055	Staff	n/a	UA Library
16 Alia M...	am137@email.arizona.edu	6017090201900940	Staff	n/a	UA Library
17 Jere...	jerej@email.arizona.edu	6017090202423595	Staff	n/a	UA Library
18 Alberto...	albertolenavara@email.arizona.edu	60170902020679063	Undergraduate	College of Engineering	Undeclared
19 Jessica...	jessicawilliams@email.arizona.edu	6017090202744537	Staff	n/a	UA Library
20 Parker Wil...	parkerwilson@email.arizona.edu	6017090202358429	Undergraduate	College of Engineering	ENGR Engineering
21 Yaelin Ben...	yaelinben@gmail.com	n/a	Other Affiliate/Community	n/a	n/a
22 Brennan Vil...	brennanvilanova@email.arizona.edu	6017090202030887	Undergraduate	College of Social and Behavioral Studies	POL Political Science
23 Jonathan Hawk...	jonathanhawkins@email.arizona.edu	6017090202081089	Undergraduate	College of Engineering	ECE Electrical & Computer Eng
24 Andras Valda Cruz-Aedo	andrasvaldacruz-aedo@email.arizona.edu	6017090202797584	Undergraduate	College of Social and Behavioral Studies	COMM Communication
25 Jion Shan	jshanson@email.arizona.edu	60170902020933427	Graduate	College of Social and Behavioral Studies	ECE Electrical & Computer Eng
26 Abigail Hackney	abigailhackney@email.arizona.edu	6017090202022659	Undergraduate	College of Fine Arts	TA Theatre Arts
27 Ramya Ramesh	ramyaramesh@email.arizona.edu	60170902020871827	Undergraduate	College of Science	BIOC Biochemistry
28 Travis...	travis@email.arizona.edu	60170902020871827	Staff	n/a	UA Library
29 Emily...	emilysingh@email.arizona.edu	60170902020871827	Undergraduate Honors	Eber College of Management	Undeclared

Spreadsheets!

Total Finished Jobs	1151	Graduate	242	Staff	43	Other Affiliates	1866				
Total N/A*	271	Graduate	43	Staff	18	Other Affiliates	1866				
Total	1482	Graduate	242	Staff	43	Other Affiliates	1866				
Total Jobs Submitted (by Month)		February	30	March	206	April	316				
May	133	June	184	July	108	August	123				
September	141	October	200	November		December					
Total	1441	College of Agriculture and Life Sciences	19	College of Architecture, Planning and Landscape Architecture	22	College of Education	9				
College of Engineering	340	College of Fine Arts	21	College of Humanities	10	College of Medicine - Phoenix	0				
College of Medicine - Tucson	45	College of Nursing	2	College of Optimal Sciences	7	College of Pharmacy	1				
College of Science	248	College of Social and Behavioral Studies	33	Colleges of Letters, Arts, and Sciences	41						
Jobs by College (To Date)		Total Jobs	Percent	Total Grams Printed	Total Cost	Total Given Away (g)	Total Given Away (\$)	Total Saved*	Original Designs	% given away	
College of Agriculture and Life Sciences	19	1%	892	\$89.20	109.00	\$10.90	\$500.50	0			
College of Architecture, Planning and Landscape Architecture	22	2%	23	\$2.30	0.00	\$0.00	\$11.50	3			
College of Education	9	1%	11.3	\$1.13	0.00	\$0.00	\$5.65	0			
College of Engineering	340	24%	9368	\$936.80	2,518.00	\$251.80	\$5,943.00	259	26.88%		
College of Fine Arts	21	1%	478	\$47.80	119.00	\$11.90	\$298.50	3	24.90%		
College of Humanities	10	1%	275	\$27.50	0.00	\$0.00	\$137.50	1			
College of Medicine - Phoenix	0	0%	0	\$0.00	0.00	\$0.00	\$0.00	0			
College of Medicine - Tucson	45	3%	697	\$69.70	39.00	\$3.90	\$368.00	1	5.60%		
College of Nursing	2	0%	84	\$8.40	0.00	\$0.00	\$42.00	0			
College of Optimal Sciences	7	0%	26	\$2.60	12.00	\$1.20	\$19.00	6	46.15%		
College of Pharmacy	1	0%	0	\$0.00	0.00	\$0.00	\$0.00	1			
College of Science	248	17%	3778	\$377.76	255.00	\$25.50	\$2,016.30	40	6.75%		
College of Social and Behavioral Studies	33	2%	801	\$80.10	14.00	\$1.40	\$407.50	4	1.75%		
Colleges of Letters, Arts, and Sciences	41	2%	545	\$54.50	7.00	\$0.70	\$115.00	3	2.89%		
Jobs by College		AME Aerospace	46	AAS African Art	1	A&E Agric & Bio	17	A&E Agric Eco	0		
A&E Agric Edu	0	AGR Agricul	0	AINS American	0	CBA Cell Bio	0	ANES Anesthes	0		
ANS Animal	0										
Total Jobs Submitted (by Month)		February	21	March	92	April	201	May	70	June	73
July	24	August	55	September		October		November		December	

REVIEW: USER STORIES

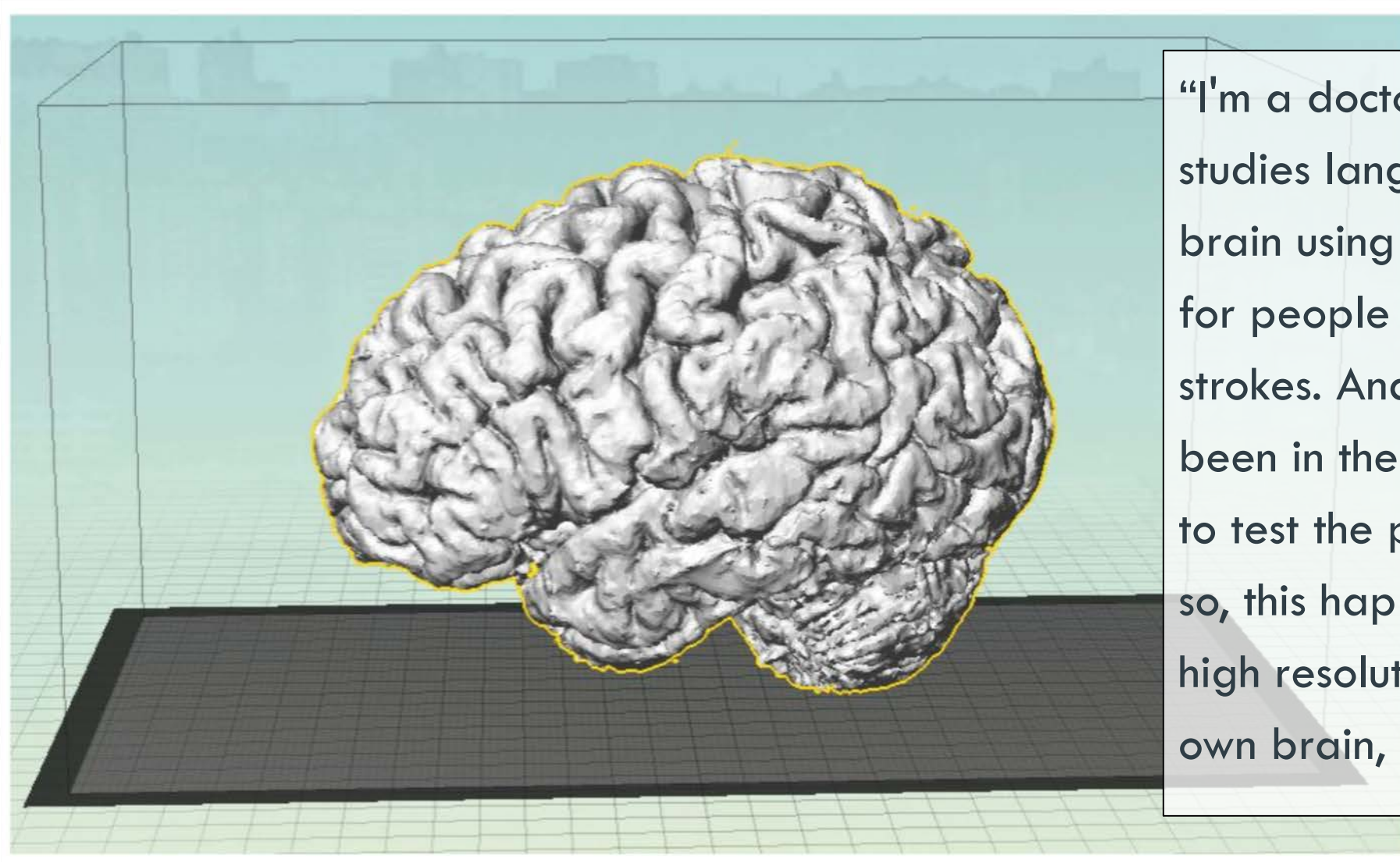
- 3d printing gave us the unique opportunity to work with other departments outside of our standard scope



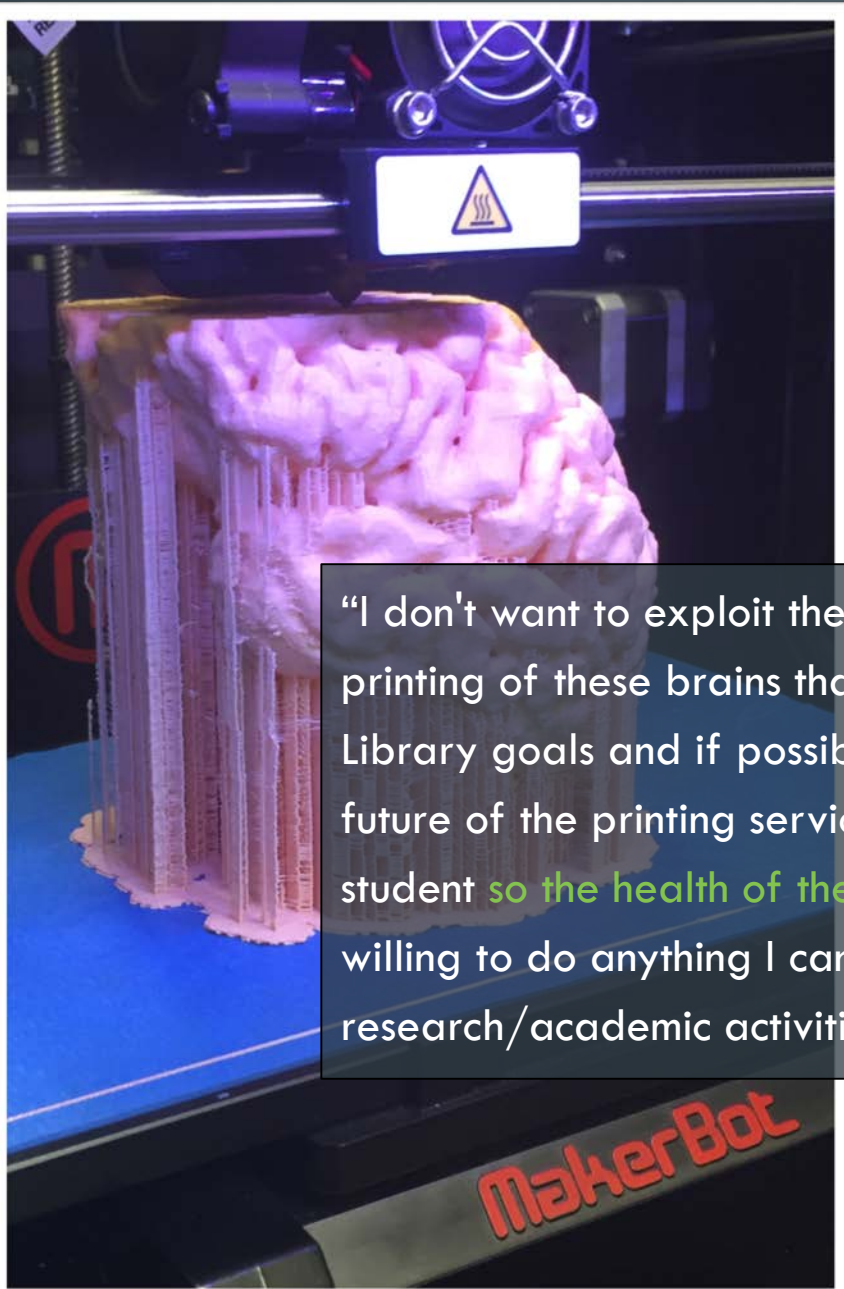
That sounds great! Some of the CAPLA shop equipment (laser cutters, 3D printer) has been under maintenance this summer. Additionally, your equipment is newer and has tons of color options, and overall your service seems friendly and easy to access. I'll be in touch toward the end of July when my students are ready to print. Thanks again!

I had a great experience working with you in the summer sending my students over to 3D printing .

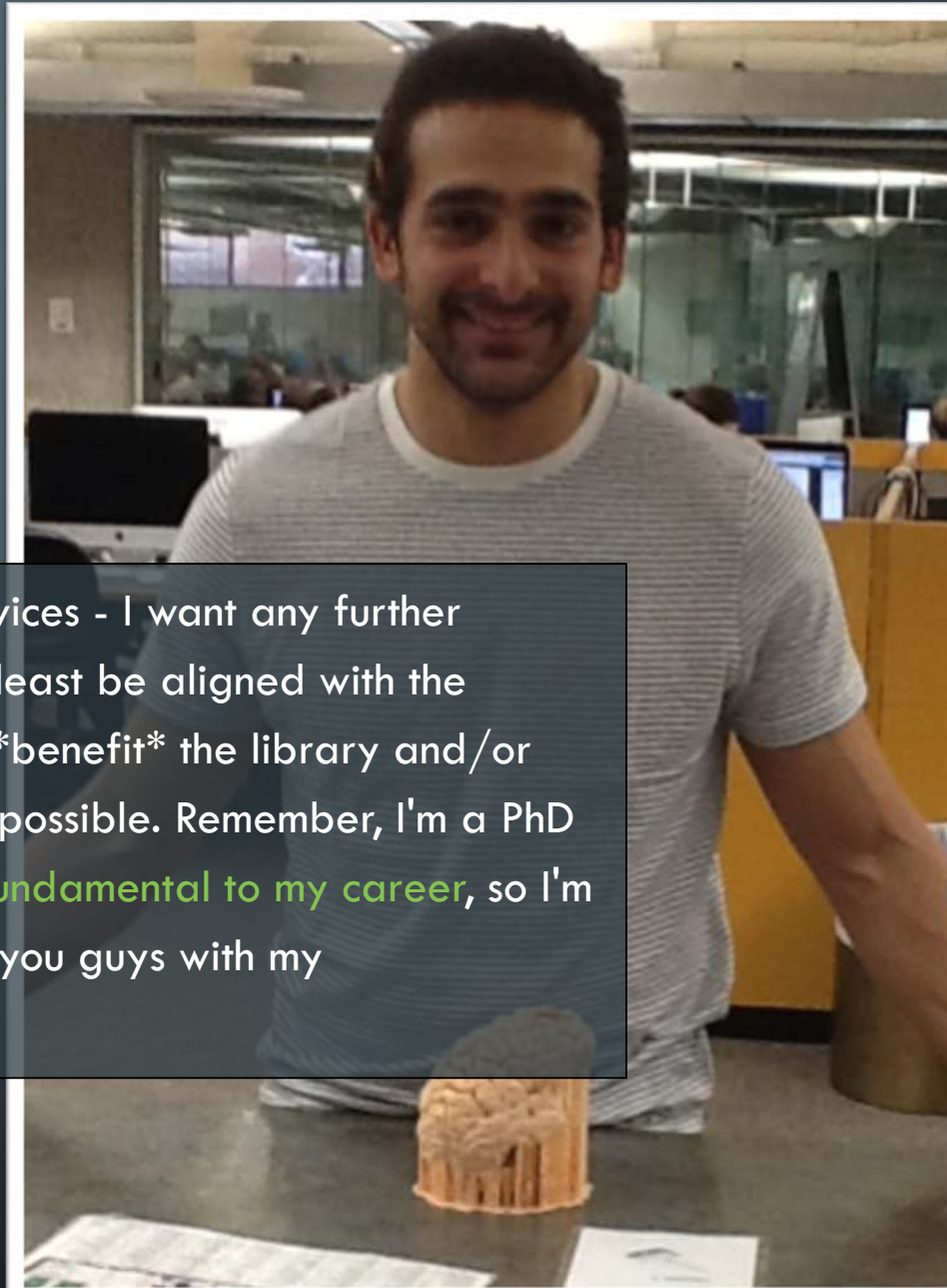
A 3D PRINTED BRAIN



"I'm a doctoral student who studies language in the brain using functional MRI for people who have had strokes. And of course I've been in the scanner myself to test the paradigms, etc... so, this happens to be a high resolution scan of my own brain, haha."



"I don't want to exploit the Library services - I want any further printing of these brains that I do to at least be aligned with the Library goals and if possible actually *benefit* the library and/or future of the printing services, if at all possible. Remember, I'm a PhD student **so the health of the library is fundamental to my career**, so I'm willing to do anything I can to support you guys with my research/academic activities."



MARKETING

- Digital Signage
- Word of Mouth – make them visible!
- Slides
- Brochures
- Website
- Events
- Social Media – Maker Mondays



MARKETING



SOCIAL MEDIA ENGAGEMENT



University of Arizona Libraries

July 20, 2015 at 7:03am · 🌐

Check out the newest color offered from our 3D printing service. What will you make with translucent blue? <http://www.library.arizona.edu/services/print/3D>



Like · Comment · Share



Maggie Melo @marijel_melo · May 12

It's alive! Thanks @uazlibraries! This is the second elephant born in AZ. 1st being Nandi, of course :) @ReidParkZoo pic.twitter.com/Nb0mQGt619



U Arizona Libraries @uazlibraries

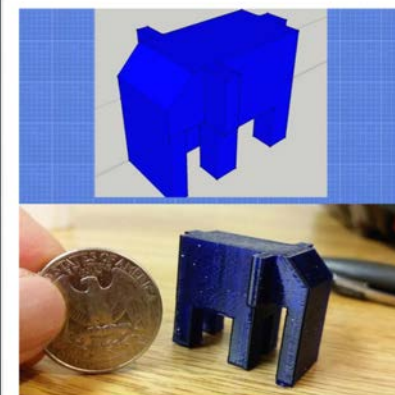
We offer 27 colors for #3DPrinting at the #UofA! Which is your favorite?
<http://ow.ly/QqT2t>
pic.twitter.com/IHVTzXeA33



Reach a bigger audience

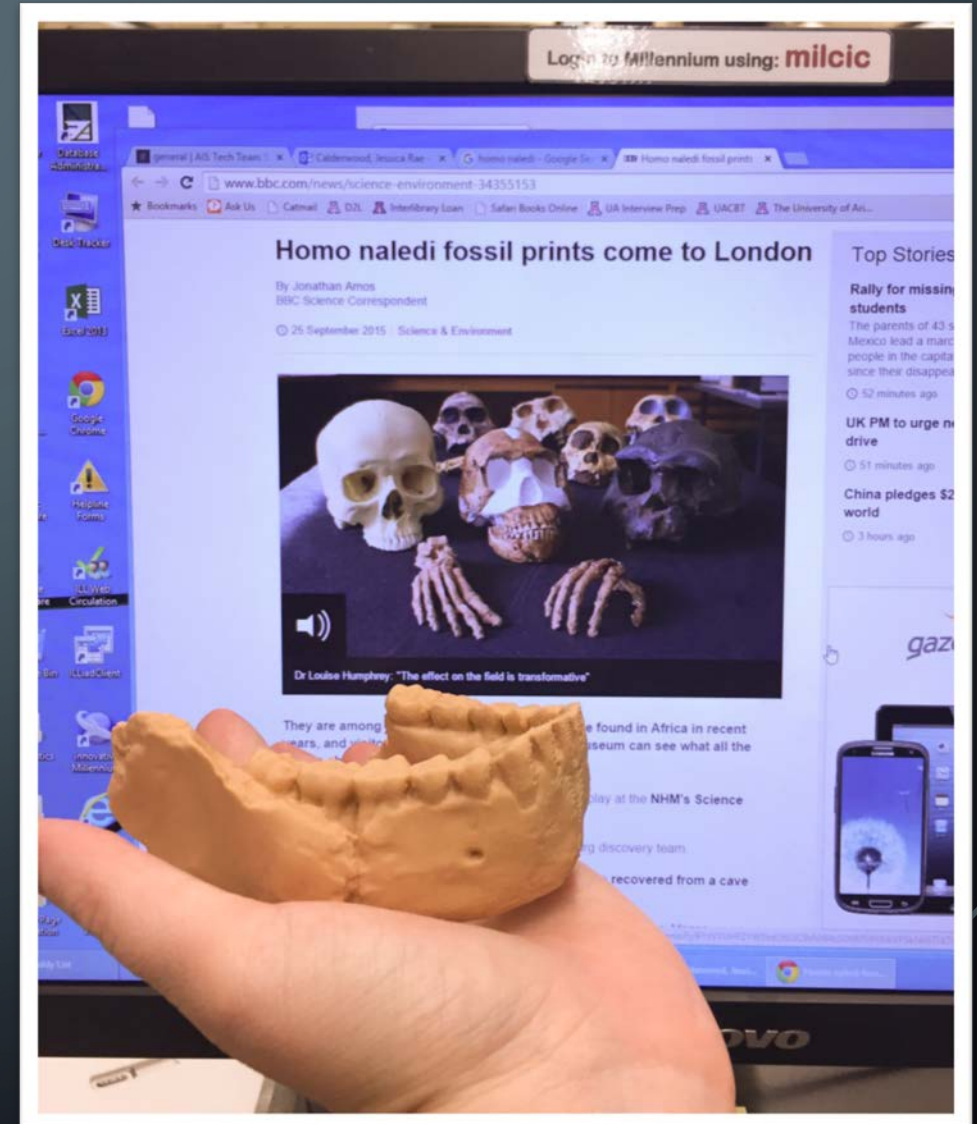
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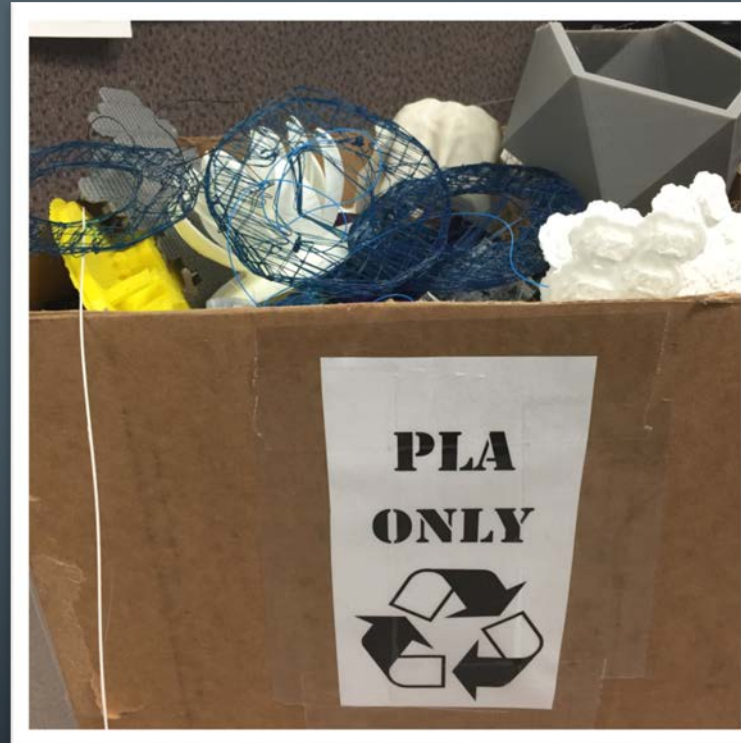
Impressions	9,599
Total engagements	1,399
Photo or video clicks	1,257
Link clicks	76
Detail expands	41
Favorites	9
Profile clicks	9
Retweets	5
Replies	1
Follows	1

OPEN ACCESS SCHOLARSHIP



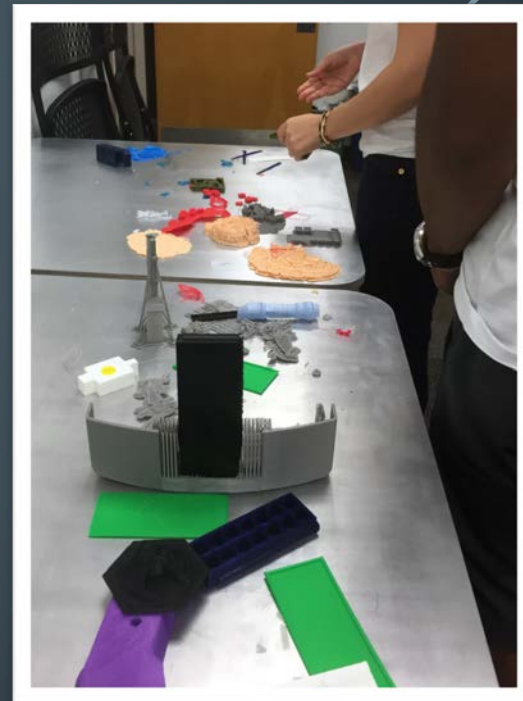
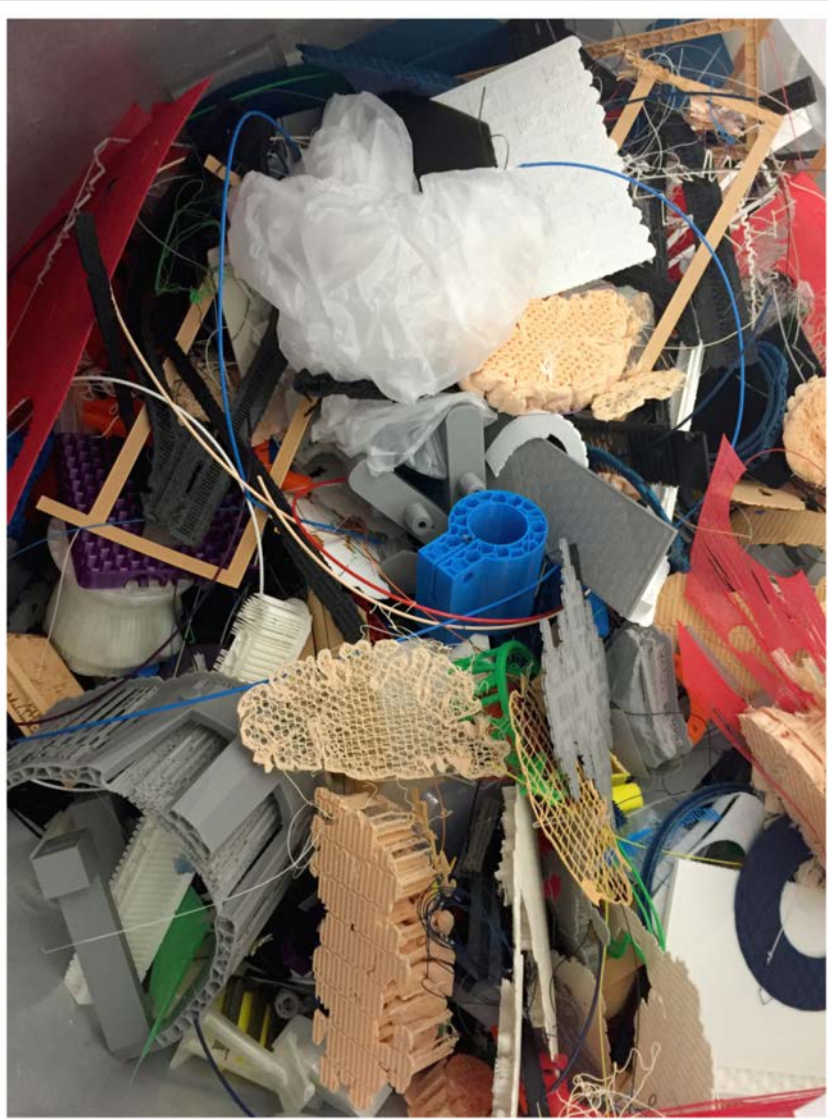


REVIEW: CHALLENGES



- Be prepared for anything
- Flexibility is necessary
- Don't be afraid to get dirty!

“REMIXED” SCULPTURE ACTIVITY



NEXT STEPS: WHAT IS 3D SCANNING?

3D Scanning is taking a full set of snapshots of an object and stitching them together to create a 3D model. The model can then be used for 3D printing, diagraming, or analysis.



QUESTIONS?



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